the woman who has not been trained in science or in scientific methods of thought. If they are read at all, they must be interpreted into popular language, at least until interest is aroused and a certain familiarity with the subject is gained.

One who knows the subject from the scientific stand-point, and at the same time realizes the needs of the average woman, is in a position to give the much-needed assistance.

This is no light task, for it often requires more knowledge to translate scientific into popular terms with any degree of accuracy, than to use the language of science.

(To be continued.)

BACTERIA IN THEIR RELATION TO HEALTH AND DISEASE *

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I. BACTERIA IN GENERAL.

The study of bacteriology began with the investigations of Anthony Van Leuwenhoek, a Dutch linen-draper, in the latter part of the seventeenth century. He was not a man of liberal education. While an apprentice he had learned the art of lens-grinding, and later in life he perfected a lens with which he saw objects of smaller dimensions than any seen before that time. In 1683 he presented the result of his observations in a paper to the Royal Society of London. This paper, with its excellent drawings, is the first record we have of the study of those organisms we now call bacteria. From that time until the middle of the present century progress in the study was exceedingly slow. It was not until 1860 that these organisms were shown to be plants, and not animals, as hitherto supposed. Since the investigations which led to the discovery of the tubercle bacillus in 1882 and of the cholera bacterium in 1883 the science has advanced by rapid strides, until to-day preventive medicine, based on bacteriology, stands in the front rank of humanity's benefactors.

Naturally, the first question which arises is, "What are bacteria?" In answer let me quote from Fränkel, whose text-book is a recognized authority: "The bacteria are the lowest members of the vegetable kingdom, closely related to the lower algæ (sea-weed and the like). They divide themselves into a series of species, well defined by growth and form, which do not run into each other. Of the forms in which the bac-

* Read before the nurses of Rochester City Hospital in 1872.

teria appear we know the globular bacteria—*micrococci;* the rod-shaped bacteria—*bacilli;* and the screw-like bacteria—*spirilla.*"

This classification is at once simple and accurate. Of course, each species of bacteria has its individual name, and in the books you will find several pages devoted to an elaborate classification, but it is of little interest to anyone but the botanist. The three names just given,—micrococci, bacilli, and spirilla,—with one or two subdivisions of the first group, are all that you need remember. A distinguishing feature of these low orders of plant life is that they reproduce their kind by division,—a feature in which they resemble the lowest forms of animal life. Sometimes when a micrococcus divides the two micrococci remain attached, and then they are spoken of as *diplococci.* Where after division a series of them remain attached together in chains they are called *streptococci;* when united in irregular bundles, like a bunch of grapes, they have the name *staphylococci.*

Of more practical importance to us is the division of all bacteria into Pathogenic (disease-producing) and Non-Pathogenic forms,—the foes and friends of man. When one reflects that the ground he walks on, the air he breathes, much of the food he eats, and the liquids he drinks all swarm with bacteria, it is a consoling thought that by far the greater number of them are his friends, and not his foes. While it is true that pathogenic bacteria produce disease and death under certain circumstances, it is also true that without the non-pathogenic bacteria life on this planet would be out of the question. By means of their green coloring-matter the higher plants, in the presence of sunlight, are enabled to decompose carbonic acid and ammonia into their elements—carbon, oxygen, nitrogen, and hydrogen—and appropriate what they need for their own growth. But these simple substances—carbonic acid and ammonia—are largely produced in nature by the decomposition and fermentation of highly-complex tissues of dead animals and vegetables. Decomposition and fermentation are the results of the presence of our friends the bacteria. Hence their importance in maintaining our life cannot be overestimated. Without vegetable life, animal life could not exist.

Of the many forms of non-pathogenic bacteria there are a few which have played a very curious and even at times a tragic rôle in the world's history.

Many honest people on seeing for the first time the phenomenon called phosphorescence have believed that they have had veritable meetings with departed spirits. Now we know that this beautiful but uncanny light is produced, in many instances at least, by bacteria. These bacteria, cultivated in tubes by themselves and placed in a dark room, have been actually photographed, tubes and all, by their own light.

Other bacteria produce various colors as they grow, the color being visible only when the bacteria are grown in masses by themselves. Thus it may happen that the milk of a particular dairy develops a deep-blue color which spreads to all the milk stored in special rooms. Again, the milk may get red instead of blue. The colors are due to the growth of particular bacteria.

Another bacterium, by its production of color, has been the cause of many a miracle, honestly believed in by both priest and people throughout the long years of the church's history. You have all doubtless read or heard of the miracle of the Bleeding Host, which was long a most powerful evidence of divine intervention with human affairs. The consecrated bread placed overnight in the moist air of church or cloister would in the morning be found sprinkled with bright-red drops. What could it be but blood? And it was left for the priest to say what this miracle portended. Nowadays the supposed miracle is produced to order in the laboratory of the bacteriologist.

Before one can make any progress in the study of bacteria he must learn the importance of, and methods of producing, sterilization of all instruments, utensils, culture media, and whatever may come in contact with the bacteria under observation. As we have already seen, bacteria are practically omnipresent. Unless we can keep away the species that we are not studying, we can learn nothing about those we are studying, owing to the confused mass of bacteria that we would find in our growing colonies. In other words, we must start with a "pure culture," as it is called, and keep that culture free from contamination by other bacteria all the time it is under observation. A pure culture, as we shall see later, is one in which there is but one species of bacteria growing. In order to obtain this freedom from contamination, the test-tubes, dishes, etc., in which the culture is to be grown must first be rendered absolutely free from living or viable bacteria. Then the material in which the bacteria are to be grown must also be sterilized. Finally, the growing colony must be protected from the bacteria which are always present in the air.

(To be continued.)